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Florida Entomologist

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VOL. XXX AUGUST, 1947 NOS. 1, 2

A FURTHER ACCOUNT OF THE EFFECTS OF DDT WHEN USED ON CITRUS TREES IN FLORIDA

By

J. T. GRIFFITHS, JR. and C. R. STEARNS[1]

Florida Agricultural Experiment Stations

In a preliminary account Griffiths and Thompson (*2*)[2] reported increases in Florida red scales (*Chrysomphalus aonidum* (L.)) following the application of DDT to citrus trees in Florida. They attributed the increase to the almost complete elimination of the insect parasites and predators which normally check the scale population. Studies on the effect of DDT have been continued. The present account deals with the population changes of Florida red scale and its attendant parasites as they were observed following two spray applications in the late summer of 1946. Three plots are reported upon. Although only two trees were included under each of the three treatments, the trends which were evidenced on these small plots are typical of the changes which have occurred following the use of DDT on citrus trees in Florida. All six trees were in a block which had received an application of DDT in an oil emulsion on April 28, 1946. Florida red scale populations had generally increased after the DDT treatment. The rate of increase had apparently been influenced both by the amounts of oil and by the amounts of DDT used in the original mixture. Many more scale insects were present on those trees which had received low concentrations of oil. Because of these scale increases, it became necessary to spray the entire block with oil in July. The trees which were used in the present experiment were treated on July 25. Two were sprayed with a 1% oil emulsion; two were sprayed with 4.8 oz. of DDT per 100 gallons of a 1% oil emulsion; and two were maintained as unsprayed controls. Figure 1 graphically presents the fluctuations in Florida red scale populations on these three plots from July 1946 to February 1947.

Estimates of the scale population were made by picking fifty leaves at random from that part of the tree which was accessible from the ground.

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[1] Entomologist and Chemist, respectively, Citrus Experiment Station.

[2] Italic figures in parentheses refer to Literature Cited at end of article.

The
FLORIDA ENTOMOLOGIST

VOL. XXX AUGUST, 1947 NOS. 1, 2

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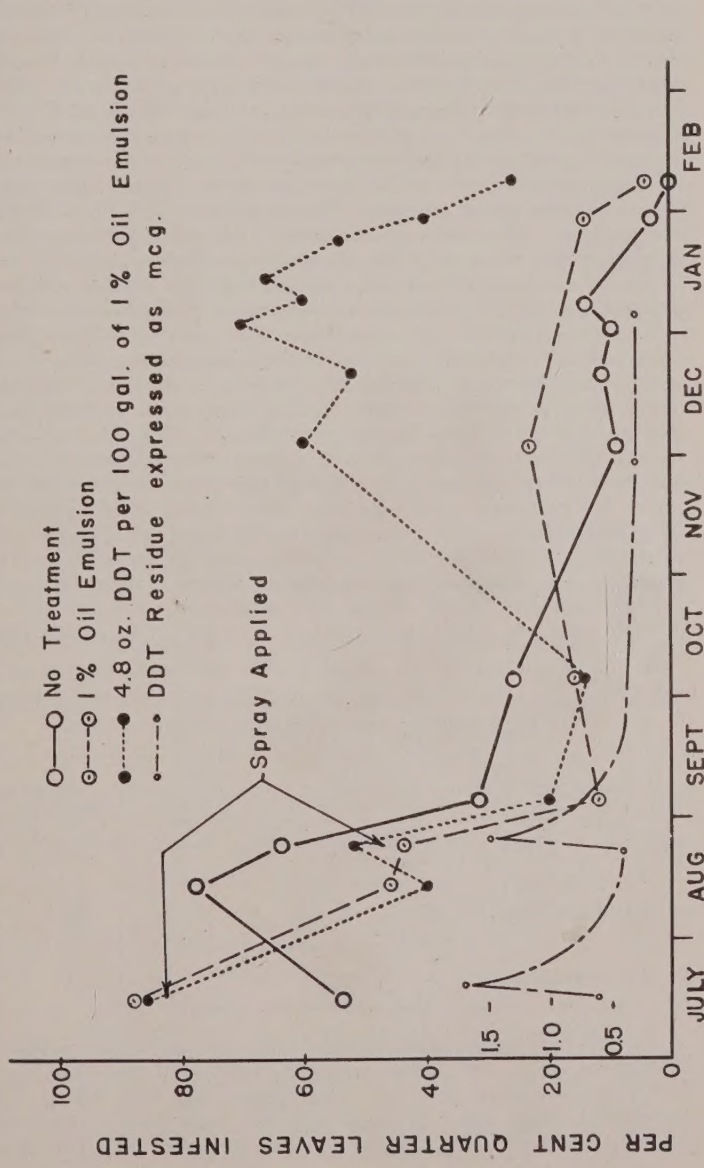
These were examined under a binocular microscope and the actual number of living first stage scales, and living second and third stage female scales recorded per quarter leaf. The population figures shown in Figure 1 are based on the average percentage of infested quarter leaves. It is believed that this is a more reliable population estimate than the highly variable figure of scales per unit area.

Pre-spray scale counts were made about July 15. On the experimental trees, averages of from 3 to 60 live scales per quarter leaf were found and high percentages of these scale were ovipositing. Thus, when the spray was applied on July 25, there was a population consisting largely of ovipositing females, crawlers, and newly settled first stage scales. This represented a rapidly multiplying population and one which would increase quickly following even a well applied oil spray. Figure 1 shows that two weeks after the spray there were from 40 to 50% of the leaves still infested. This was true in spite of the fact that apparently 90% or better of the scales present at the time of application were killed by the spray. Therefore, it was decided to respray the plots in order to minimize scale insect damage. Accordingly, the same treatments were repeated on August 21. Two weeks later, the percentage of infested leaves for the two treated plots averaged less than 20% and actual live scales were again reduced approximately 80 to 90%. During this same period, the population on

the unsprayed plot had increased and reached a maximum in August. It then began a decrease which continued steadily until about the first of December.

FIGURE 1



Populations on the sprayed plots appeared to be somewhat stabilized until October. At that time there was another period of ovipositing activity which resulted in slight increases where oil had been used and a very marked increase on the DDT sprayed trees. In spite of the ovipositing activity, the unsprayed trees continued to show a decreasing population. About the first of December, this latter infestation began a very slow increase which continued through the first half of January. The DDT sprayed trees also had increasing infestations until late January. Although samples on the oil sprayed plots were not made in late December or early January, it is believed that these populations made slow increases throughout that period of time. In all three cases, populations showed decreases in late January which continued through February 15 when observations were stopped. These decreases followed a temperature drop to 33° F. on January 22 and a low of 22° on the morning of February 6.

As previously stated (*2*), it appeared that the Florida red scale increases following DDT applications were due to the elimination of insects which were parasitic or predaceous upon the scales. The initial effects of oil or oil-DDT sprays on the twice-stabbed lady beetle, *Chilocoris stigma* (Say), were checked during the July 25 spray. Squares of canvas were placed under several trees which were to be sprayed and the dead lady beetles which fell on them were counted 24 hours after the spray had been applied. On trees which were sprayed with 1.0% oil there were only 8 dead beetles per unit area. On the oil-DDT trees, there were 39 dead beetles per unit area. Not only were more beetles killed initially where DDT was added to the spray, but the DDT apparently resulted in a practically complete elimination of beetles from the trees for a period of several weeks. Although the exact extent to which these beetles reduce or check scale infestations has not been determined, there can be no question that they are predaceous upon scale and are an important factor in scale control.

TABLE 1.—PARASITE COUNTS BEFORE AND AFTER JULY 25 SPRAY EXPRESSED AS EVIDENCES OF PARASITISM PER 100 LIVE SCALES.

Treatment	DDT		Oil		Unsprayed	
Date	7/15	8/10	7/15	8/10	7/15	8/10
In 2nd Stage Scale	15	0	9	10	20	50
In 3rd Stage Scale	3	0	6	2	3	6

Two hymenopterous parasites have been recorded by the authors from Florida red scale. *Prospaltella aurantii* (How.) is found as a late stage larva and as a pupa in second stage female and male scales. *Pseudohomalapoda prima* (Gir.) is found as a late stage larva or pupa in third stage female scale. The number of dead parasites, live parasites ,and

emergence holes are recorded from a 50 leaf sample. Then, ratios of evidences of parasitism per 100 live scales of a given stage are set up for comparison. Table 1 gives the information for all three plots before and after the July 25 spray application. Prior to the spray it appeared that all the plots had fairly normal parasite/scale ratios. On August 10, no evidences of parasitism were recorded on the DDT sprayed plot. On the same date, there was apparently no difference between the pre- and post-spray counts on the oil sprayed trees. The parasite ratios had definitely increased on the unsprayed trees. It should be noted that after this date, the actual scale infestation on the unsprayed trees began a steady decrease.

Apparently, oil alone did not produce a differential in kill between the scale and its parasites. In order to kill a parasite in the scale insect, the oil must first reach the scale. Thus, parasites and scale would both be killed in the same proportion. However, DDT remained after the spray as a residual toxicant. It appears that this residual toxicity resulted in differential mortalities of the scale and its parasites. It is suggested that the DDT residue probably killed both the scale crawlers and the free living adult stages of the parasites for a period of time. Then, when the residue became reduced to a certain, as yet unknown level, the crawlers were able to move about and settle, but the free living parasitic forms continued to be killed for an additional period of time. Other factors may be of importance, but, in any case, it is obvious that the DDT application resulted in an almost complete elimination of parasites on those trees to which it was applied.

Table 2 gives the parasite incidence during December and January. Careful checks on the oil sprayed trees were not made and therefore no data for that plot are included. However, casual observation indicated a

TABLE 2.—A COMPARISON OF RED SCALE PARASITES FROM DECEMBER THROUGH JANUARY ON DDT SPRAYED AND UNTREATED PLOTS.

	Second Stage Scale and Parasites					
	DDT			Unsprayed		
Date	Evidences of Parasites	Live 2nd Stage Scale	Parasites per 100 Live Scale	Evidences of Parasites	Live 2nd Stage Scale	Parasites per 100 Live Scale
12/3	7	132	5.3	15	2	750
12/20	5	112	4.5	13	0	13/0
1/2	17	209	8.1	18	7	257
1/29	3	72	4.2	3	0	3/0
	Third Stage Scale and Parasites					
12/3	0	21	0/21	3	7	43
12/20	4	31	12.9	4	2	200
1/2	0	38	0/38	3	4	75
1/29	4	159	2.5	2	3	67

normal parasitic rate on these trees. By December, the parasite populations on the unsprayed trees had reached a very high level. The counts exhibited considerable variation. This was due to the fact that where low scale populations are encountered, the addition or subtraction of one scale or parasite makes a great difference in the ratio between the two. By December, the parasite ratios on the DDT sprayed trees had returned to normal and they continued that way through January and into February.

Checks on the actual amount of the p,p' DDT were made at intervals throughout the observation period. They were made according to a modification[3] of the method of Schechter et al. (*3*) which included the following technique. Twenty-five old leaves were selected at random from the trees to be checked and an area 1 in.^{2} was punched from each leaf. These punched samples were then extracted for one hour with 150 mls. of petroleum ether (b.p. 35° — 60° C.) in a Soxlet extractor. The volume was reduced by evaporation to 15 mls. and the material transferred to a 50 ml. centrifuge tube. The extraction flask was washed twice with small portions of ether and the washings were added to the centrifuge tube. The ether was evaporated and the tubes cooled in cold water. Five mls. of nitrating mixture composed of 1 to 1 by volume of fuming nitric acid (sp. gr. 1.50) and concentrated sulfuric acid (sp. gr. 1.84) were added, and the tubes were heated in a water bath for one hour at 100° C. After cooling the tubes in cold water, 25 mls. of ice water were added. The solution was transferred to a 60 ml. separatory funnnel, and after thoroughly washing the tubes, the wash was added to the funnel. This was then extracted with 20 mls. of a solution containing 60% petroleum ether and 40% benzene. It was shaken vigorously for one minute and after separation of the layers, the aqueous portion was discarded. The solution was washed with 5 mls. of water and the aqueous portion discarded. After a second washing with 10 mls. of sodium hydroxide, the aqueous portion was again discarded. Following this a third washing with water was performed. The petroleum ether-benzene portion was then transferred to a dry flask, placed in a water bath, and evaporated to dryness under vacuum. Five mls. of anhydrous benzene and 10 mls. of sodium methylate solution (10 gr. per 100 mls. of anhydrous methanol) were added to the flask and the color read within 15 minutes. The amount of p,p' DDT was calculated from standard curves prepared from pure tetra-nitro p,p' DDT.

A curve showing the changes in the amount of DDT on the leaves of the DDT sprayed trees is shown in Figure 1. All trees in this experiment had received DDT in April, 1946. On July 24, approximately 0.5 mcg. DDT/cm^2 was found on all leaf samples checked. Since parasitic and predaceous populations were apparently normal at that time, it may be concluded that that amount of DDT did not affect them adversely. On July 25, the application of 4.8 oz. of DDT per 100 gallons of a 1.0% oil emulsion resulted in a deposit of approximately 1.0 mcg. DDT per cm.^{2} of leaf surface. The curve in Figure 1 showing the decrease in DDT to less than 0.5 mcg./cm.^{2} by August 22 is theoretical, but it is based upon previous unpublished work which showed that DDT on citrus foliage in

[3] Modification worked out by Dr. James B. Redd, formerly Insecticide Chemist, Citrus Experiment Station.

Florida was reduced according to a similar type curve. On August 22 approximately 1.0 mcg. DDT/cm.^{2} was again deposited on the foliage. The decrease in DDT residue as shown on the continuing curve is still theoretical, but it is believed to be essentially accurate. Analyses in late November and December showed about 0.5 mcg. DDT/cm.^{2} on the trees sprayed in July and again in August. At that same time there was still approximately 0.5 mcg./cm.^{2} of leaf surface on the trees which had received no DDT since the preceding April. Ebeling (*1*) suggested that DDT was carried into the tissues of the leaf by kerosene. It appears quite possible that a similar phenomenon may occur where DDT is applied in conjunction with a regular miscible spray oil. The fact that this amount of residual DDT did not affect the parasatic population appears to substantiate this theory. Further work on this problem is proceeding. In any case, in this study, it appeared that the damage to the parasitic and predaceous populations was accomplished during a short interval after each spray application when the DDT residue was above 0.5 mcg. DDT/cm.^{2} of leaf surface.

Summary and Conclusions

1. In July 1946, three series of plots were established in a block of orange trees which had received a DDT application in April. There had been a marked increase in Florida red scales following the April spray. One plot served as an unsprayed control; one received a 1% oil emulsion; and one received 4.8 oz. DDT per 100 gallons of a 1% oil emulsion. They were treated in July and again in August.

2. The lady beetle, *Chilocoris stigma* (Say) was virtually eliminated on the DDT sprayed trees. They were not materially affected by the 1% oil spray.

3. The Florida red scale infestation was initially reduced, but later it increased to serious proportions on the DDT-oil plot. It was reduced on the oil sprayed plot. After an initial increase on the unsprayed trees, it declined almost to zero by December.

4. Hymenopterous parasites of Florida red scale were eliminated by the DDT application, but they appeared to be more or less unaffected by oil sprays alone. By December, parasite populations appeared to have returned to normal on the DDT sprayed trees.

5. The use of 4.8 oz. of DDT per 100 gallons of spray resulted in an additional deposit of 1.0 mcg. DDT/cm.^{2} of leaf surface. This amount of DDT was reduced to about 0.5 mcg./cm.^{2} within four weeks. The damage to parasitic and predaceous populations was apparently accomplished within that interval of time.

6. Approximately 0.5 mcg. DDT/cm.^{2} of leaf surface was retained on foliage for as long as nine months. In this experiment, within four weeks after spraying, residues had been reduced to this level and they remained there for at least five months. Apparently there was an irreducible minimum of DDT which remained on or inside the leaf for a very prolonged period of time. This amount of DDT appeared to have no effect upon Florida red scale or its parasites or predators.

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THE MOSQUITOES OF THE FLORIDA KEYS

By A. E. PRITCHARD,[1] E. L. SEABROOK,[2] and J. A. MULRENNAN[3]

The Florida Keys comprise a chain of islands which curves southwestward from the southern end of peninsular Florida. These islands form the southernmost part of the United States; and their fauna and flora represent a connecting link between the Caribbean region and continental North America.

The Florida Keys are naturally divided into two groups which differ considerably in geology and vegetation. The Upper Keys extend from Soldier Key, near Miami, to Bahia Honda channel. These are narrow keys which are composed of Key Largo limestone, a formation which originated as a coral reef. The Lower Keys, extending from Bahia Honda to Key West, are composed of Miami oölitic limestone, the same formation which is found in the southern part of the mainland. The surface of the oölite is often marked with solution holes. The Dry Tortugas, and other islands beyond Key West, are present-day coral reefs which appear as developing atolls.

The vegetation of the Keys consists of rather scrubby and often dense tropical hammock and mangrove swamps. Such plants as the poisonwood (*Metopium toxiferum* Kr. & Urb.), Jamaica dogwood (*Ichthyomethia piscipula* A. S. Hitch.), thatch palms (*Thrinax* spp.) button-wood (*Concarpus erecta* L.), black mangrove (*Avicennia nitida* Jacq.), white mangrove (*Laguncularia racemosa* Gaertn.), and red mangrove (*Rhizophora mangle* L.), are common. The plants on the Lower Keys are considerably more diversified, and extensive stands of the slash pine (*Pinus caribaea* Morelet) and the silver thatch palm (*Cocothrinax jucunda* Sarg.) are found on several of the islands.

The elevation of the Florida Keys is low, not rising above 15 feet. The period of maximum precipitation is generally from May to November, with the greatest rainfall occurring during the fall when tropical storms may be expected. Conditions in the Keys are apt to be arid during the winter and early spring at which time fresh water pools are scarce. Temperatures are warm enough to permit breeding throughout the year, but, in general, the abundance of mosquitoes is dependent upon the rainfall and tidal fluctuation.

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[1] U. S. Public Health Service.

[2] Palm Beach County Anti-Mosquito Control District.

[3] Florida State Board of Health.

Very little has been known concerning the distribution and abundance of mosquitoes which occur on these islands. *Culex atratus* Theob., for instance, is commonly found in the Florida Keys; yet this species was not recorded from this area until 1944, on the basis of a single male which had been taken in a light trap (Roth and Young, 1944). Six species which have been recorded from the Keys were original records of occurrence in the United States. Two additional species, *Psorophora johnstonii* Grab. and *Aedes euplocamus* D. and K. are here recognized for the first time in the United States.

Several species of mosquitoes which are known to occur in southern Florida have not been found on the Keys. *Anopheles quadrimaculatus* Say and *A. walkeri* Theob. are known to occur in the Miami region, but these species have not been recognized from the Keys. *Megarhinus rutilus* Coq. has been found by the writers to breed commonly in the bromeliads of southern Florida. It has not been found on the Keys, however, probably because the bromeliads on the islands are generally small and devoid of water during a considerable part of the year. Treehole breeding places are similarly scarce on the Florida Keys, and this further accounts for *Megarhinus* not having been found. The genus *Mansonia* is common in southern Florida, but it is yet unrecognized in the Keys.

Conversely, several species, such as *Culex bahamensis* D. and K. and *C. elevator* D. and K. are of widespread occurrence in the Antillean area and the Florida Keys, but they have not been found on the mainland. *C. opisthopus* Komp is known from the Caribbean region and is also widespread in southern Florida,* but this species has not been found on the Keys.

Fourteen species of mosquitoes have been recorded previously from the Florida Keys. Twenty-nine species are here listed from this area. An unidentified male of *Culex (Culex)* from Plantation Key and a widely distributed species of *Culex (Melanoconion)* which is undescribed are not included. Bibliographic references are cited only for those papers in which records or discussions are originally given for the Keys.

This article is based on collections made during the period October, 1945, to December, 1946. A number of workers have contributed to the study. Mr. D. C. Thurman and Mr. M. W. Provost have aided considerably in all phases of the study. Mr. Ray Krueger, Mr. Alan Obermuller and Mr. Fred Miller have made considerable collections. Mrs. Ernestine Basham, Mrs. Nina Branch, and Mr. T. E. Duffey have performed a large part of the laboratory rearing and identification work. Dr. Alan Stone and Mr. W. H. W. Komp have checked certain determinations. Mr. G. H. Bradley has rendered valuable advice in the preparation of the annotated list. To all of these workers, the authors acknowledge their thanks.

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* Originally recorded from Florida at Ft. Lauderdale (Pratt, Denning and Wirth, 1945), more recently *C. opisthopus* has been taken in light traps near Ft. Lauderdale, 12 September 1945 (Seabrook); Jupiter, 22 July 1946 (Van Vleck); Cape Sable, 16-18 Dec. 1946 (Wilson); and Charlotte Harbor, 19-21 Dec. 1946 (Bennett).

AN ANNOTATED LIST OF THE MOSQUITOES OF THE FLORIDA KEYS

ANOPHELINI

Anopheles (Anopheles) atropos Dyar and Knab.

Anopheles atropos Dyar and Knab: Howard, Dyar, and Knab, Mosq. N. & C. Amer. and W. I., 4:1033, 1917 (Fla. Keys): Fisk, Jour. Econ. Ent., 32:469, 1939 (Key West); King, Bradley, and McNeel, U.S.D.A. Misc. Publ., 336:37, 1942 (Elliott Key); Roth and Young, Ann. Ent. Soc. Amer., 37:84, 1944 (Boca Chica); Wirth, Proc. Ent. Soc. Wash., 47:200, 1945 (Key Largo).

This mosquito is very common throughout the entire Keys, breeding primarily in the shallow tidal waters of the mangrove swamps. The following new locality records are based on larval collections: Windley Key, Ramrod Key, Grassy Key, Lower Matacumbe Key, Torch Key, Sugar Loaf Key, No Name Key, Summerland Key, Cudjoe Key, and Vaca Key. Light trap collections made on Stock Island and Big Pine Key have yielded considerable numbers of this species.

Anopheles (Anopheles) crucians Wiedemann

This species is of infrequent occurrence on the Keys, although it is very common on the adjacent mainland. Adults have been taken in the light trap on Stock Island and in resting places on Key Largo. A few larvae which were collected on Key Largo and Lower Matacumbe Key represent *A. crucians bradleyi* King, while larvae collected on Ramrod Key, Big Pine Key, and Lower Matacumbe Key represent *A. crucians crucians* Wied.

Anopheles (Nyssorhynchus) albimanus Wiedemann

Anopheles albimanus Wiedemann: Gardner, Publ. Health Rep., 19:1651, 1904 (Key West); King, South. Med. Jour., 30:943, 1937: Pritchard, Seabrook and Provost, Mosq. News, 6:183, 1947 (Big Pine Key).

The recent finding of a larva of this species on Big Pine Key, together with a review of McDonnell's early findings in Key West, have led the authors to believe that this anopheline is established on the Florida Keys and is possibly endemic.

CULICINI

Aedes (Finlaya) triseriatus (Say)

The larvae of this mosquito have been found in considerable numbers in the small tree holes of gumbo limbo (*Bursera Simarubra* Sarg.) on Upper Matacumbe Key and on Plantation Key.

Aedes (Ochlerotatus) atlanticus Dyar and Knab.

A. atlanticus has been taken frequently in the light trap on Stock Island. The identifications have been based on male terminalia. Larvae have been collected in temporary rain pools on Big Pine Key.

Aedes (Ochlerotatus) euplocamus Dyar and Knab.

Three fourth instar larvae of this species were collected in a temporary pool on Vaca Key, 15 November 1945 (Seabrook and Thurman). Both Dr. Alan Stone and Mr. W. H. W. Komp have confirmed the identification. This constitutes the first record of occurrence of this Central American Species in the United States.

The larva of *A. scapularis* (Rond.) is very similar to that of *A. euplocamus;* and since this closely related species is of widespread occurrence over the Caribbean area, one might expect it to occur on the Florida Keys rather than *A. euplocamus.*

Aedes (Ochlerotatus) sollicitans (Walker)

Aedes sollicitans (Walker): Dyar, Proc. U. S. Nat. Mus., 62:90, 1922 (Ramrod Key); Roth and Young, Ann. Ent. Soc. Amer. 37:84, 1944 (Boca Chica).

This species was found to be a serious pest on Key West and Stock Island. It has been collected in smaller numbers on Vaca Key.

Aedes (Ochlerotatus) taeniorhynchus (Wiedemann)

Aëdes niger (Giles) (not Theobald): Howard, Dyar and Knab, Mosq. N. & C. Amer. and W. I., 4:675, 1917 (Fla. Keys, Knights Key, Key West, Loggerhead Key-Dry Tortugas).

Aedes taeniorhynchus (Wiedemann): Roth and Young, Ann. Ent. Soc. Amer., 37:84, 1944 (Boca Chica); Wirth, Proc. Ent. Soc. Wash., 47:200, 1945 (Key Largo).

An ubiquitous species which is often found in enormous numbers. Collections of numerous larvae and adults were made on Stock Island, Crawl Keys, Cudjoe Key, Torch Key, Big Pine Key, Bahia Honda Key, Vaca Key, Lower Matacumbe Key, Windley Key, and Key Largo.

Aedes (Ochlerotatus) tortilis (Theobald)

Aedes tortilis (Theobald): Staebler and Buren, Pub. Health Rep. 61:685, 1946 (Key West).

This species was originally recorded from the United States on a basis of a single female taken in a light trap on Key West, 28 August 1945. New records for the Florida Keys include one female, Vaca Key, 13 October 1945, biting (Pritchard); one female, Vaca Key, 15 November 1945, biting (Pritchard); one female, Cudjoe Key, 15 October 1945, biting (Seabrook); and one female, Stock Island, 30 October 1945, light trap. One male was taken in a light trap in the everglades, Clewiston, Florida, on 26 October 1945. Staebler and Buren suggested the probability that *A. tortilis* had been recently introduced into this country by aircraft. However, the widespread occurrence of this species in the Keys and southern Florida leads the present writers to believe that it is endemic.

The mesonotal pile of the Florida females is reddish brown, considerably darker than that of specimens collected by the senior author in Jamaica (near the type locality) and Puerto Rico. The mesonotal vestiture of the Clewiston male and others reared in Puerto Rico is white; this sexual difference has not been previously described. Dr. Alan Stone has verified the determination of this species.

Aedes (Stegomyia) aegypti (Linnaeus)

Aëdes calopus (Meigen): Howard, Dyar, and Knab, Mosq. N. & C. Amer. and W. I., 4:839, 1917 (Key West).

The yellow fever mosquito is common in Key West, although a considerable amount of control has been obtained in the past few years. A few larvae were collected on Cudjoe Key and Plantation Key.

Culex (Culex) bahamensis Dyar and Knab.

Culex corniger Dyar (not Theobald): Proc. U.S.N.M., 62:23, 1922 (Knights Key); King, Bradley, and McNeel, U.S.D.A. Misc. Pub., 336:41, 1939.

Culex bahamensis Dyar and Knab: Fisk, Jour. Econ. Ent., 32:469, 1939 (Key West); King, Bradley, and McNeel, U.S.D.A. Misc. Publ., 336:42, 1942 (Elliott Key); Roth and Young, Ann. Ent. Soc. Amer., 37:84, 1944 (Boca Chica Key); Wirth, Proc. Ent. Soc. Wash., 47:199, 1945 (Key Largo, Elliot's Key).

C. bahamensis is found locally in large numbers when temporary rain pools are favorable for breeding. A number of larvae were collected on Lower Matacumbe Key in February.

Culex (Culex) nigripalpus Theobald

This species is found commonly throughout the Keys. Collections of larvae or adults were made on Stock Island, Cudjoe Key, Big Pine Key, Vaca Key, Upper Matacumbe Key, Plantation Key, and Key Largo.

Culex (Culex) quinquefasciatus Say

Culex quinquefasciatus Say: Howard, Dyar, and Knab, Mosq. N. & C. Amer. and W. I., 3:356, 1915 (Key West).

Larval, light trap, or resting place collections of this common species were made on Key West, Stock Island, Cudjoe Key, Big Pine Key, Plantation Key, and Key Largo.

The proximal air tuft on the siphon of the larva may occur either beyond the pecten or proximal to the distal end of the pecten. The variability of this character renders it of little value as an aid in the identification of the species as used by King, Bradley, and McNeel (1939), and Matheson (1944).

Culex (Culex) salinarius Coquillett

This species appears to be of infrequent occurrence on the Keys. A few larvae were taken on Cudjoe Key and Vaca Key, and a few males have been taken in the light trap on Stock Island.

Culex (Melanoconion) atratus Theobald

Culex atratus Theobald: Roth and Young, Ann. Ent. Soc. Amer., 37:84, 1944 (Boca Chica Key); Wirth, Ann. Ent. Soc. Amer., 37:199, 1945 (Elliot's Key); Pritchard, Seabrook, and Provost, Mosquito News, 6:184, 1947 (Big Pine Key).

C. atratus is a very common species throughout the Keys. Larval collections (many reared) were made on Stock Island, Saddle Bunch Keys, Ramrod Keys, Crawl Keys, Sugar Loaf Key, Cudjoe Key, Summerland

Key, Torch Key, Big Pine Key, Little Pine Key, Vaca Key, Long Key, Grassy Key, Lower Matacumbe Key, Plantation Key, and Key Largo. Light trap collections (males) were made on Stock Island, Big Pine Key and Vaca Key.

The following light trap collections constitute the first records of occurrence of this species on the Florida mainland: 1 male, Cortez, 29 October 1946 (Leeper); and 1 male, Copeland, 17 September 1946 (Simmonds).

Culex (Melanoconion) elevator Dyar and Knab

Culex elevator Dyar and Knab: Wirth, Proc. Ent. Soc. Wash, 47:200, 1945 (Key Largo); Pritchard, Seabrook, and Provost, Mosq. News, 6:184, 1947 (Big Pine Key).

This species is of frequent occurrence throughout most of the Keys. Recent locality records include reared material from Ramrod Key and Vaca Key.

Culex (Melanoconion) erraticus (Dyar and Knab)

C. erraticus appears to be rare in the Keys, although it is very common on the adjacent mainland. A few males have been taken in the light trap on Stock Island.

Culex (Melanoconion) pilosus (Dyar and Knab)

C. pilosus is of generally frequent occurrence throughout the Keys. A few larvae have been collected on Cudjoe Key, Torch Key and Vaca Key; and several males were collected in spider webs on Key Largo. A number of males have been taken in the Stock Island light trap at the southern end of the Keys where this is a common species.

Culiseta (Culiseta) inornata (Williston)

A number of specimens of *C. inornata* have been taken in the light trap on Stock Island.

Deinocerites cancer Theobald

Deinocerites cancer Theobald: Roth and Young, Ann. Ent. Soc. Amer., 37:84, 1944 (Boca Chica Key).

The larvae of this species breed commonly in crab holes throughout the Florida Keys. Numerous larval collections were made on Stock Island, Cudjoe Key, Big Pine Key, Bahia Honda Key, Vaca Key, and Key Largo, while light trap collections were made on the latter two Keys.

The lower head hairs of the larva are occasionally double, triple, or multiple on one or both sides, so that this character is of limited value for the separation of this species from *D. spanius* (Dyar and Knab) as used by Fisk (1941) and Matheson (1944).

Psorophora (Grabhamia) confinnis (Lynch)

P. confinnis has been taken in large numbers in a light trap on Stock Island, and it is probable that it is a common species throughout the Keys. A few larvae were collected on Big Pine Key and Vaca Key.

Psorophora (Grabhamia) pygmaea (Theobald)

Culex nanus Coquillett, Canad. Ent., 35:256, 1903 (Key West).

P. pygmaea is a common species in the Caribbean region, but it has not been recognized from the Florida Keys since 1903. The even distribution of white and dark scales on the tibiae in contradistinction to the patches of white scales on the tibiae of *P. confinnis* makes this species easily recognized in the field.

Psorophora (Janthinosoma) johnstonii (Grabham)

Psorophora varipes King, Bradley and McNeel (not Coquillett), U.S.D.A. Misc. Pub., 336:51, 1939 (Matecumbe).

P. johnstonii has been previously known only from the Greater Antilles. The following biting collections constitute the first records for the United States: 5 females, Cudjoe Key, 13 October 1945 (Seabrook and Pritchard); 1 female, 30 October 1945 (Seabrook); 2 females, 12 December 1945 (Seabrook). One male was taken in a light trap on Cudjoe Key, 14 October 1945. Dr. Alan Stone has confirmed the identification. The larva is undescribed.

It is probable that an examination of the female on which King, Bradley and McNeel based their record will reveal that it represents *P. johnstonii.*

Psorophora (Psorophora) ciliata (Fabricius)

Psorophora ciliata (Fabricius): Howard, Dyar and Knab, Mosq. N. & C. Amer. & W. I., 4:535, 1917 (Key West).

A few specimens of this species have been taken in the light trap on Stock Island.

Psorophora (Psorophora) howardii Coquillett

A few specimens of *P. howardii* have been taken in the light trap on Stock Island.

Uranotaenia lowii Theobald

Uranotaenia lowii Theobald: Pritchard, Seabrook, and Provost, Mosquito News, 6:184, 1947 (Big Pine Key).

U. lowii is a common species throughout the Keys. Larval collections (many reared) were made on Cudjoe Key, Big Pine Key, Vaca Key, Lower Matacumbe Key, Plantation Key, and Key Largo. Many adults have been taken in the light trap on Stock Island.

Uranotaenia sapphirina (Osten Sacken)

A few specimens of *U. sapphirina* have been taken in the Stock Island light trap.

Wyeomyia (Wyeomyia) mitchellii (Theobald)

A few larvae of this species were collected from bromeliads on Cudjoe Key.

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RESEARCH REQUEST

Mr. J. B. Gerberich, Dept. of Biological Science, Michigan State College, East Lansing, Michigan, wants to obtain reprints, copies of unpublished manuscripts, and results of observations made in connection with the biological control of mosquitoes. He wants to bring this information together in the form of annotated bibliographies.

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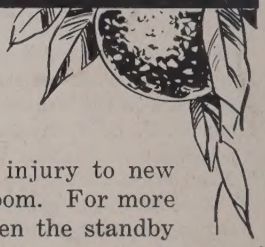

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